DESCRIPTION FOR THE GENERAL PUBLIC

Doping mechanism of oxygen into GaN thin films by magnetron sputtering and analysis of ohmic contact formation with highly doped subcontact n-GaN:O layer to n-GaN and AlGaN/GaN HEMT transistors

Gallium nitride (GaN) is considered currently one of the most promising semiconductor material to operate at high power, frequency and temperature outperforming conventional semiconductors, mainly silicon (Si). The AlGaN/GaN heterostructure is the basis for the operation of high electron mobility transistors (HEMT), considered as the best of elements for high frequency and high power electronic.

The barriers in a full use of the unique properties of both gallium nitride and HEMT transistors as well as in the development of nitride technology are the reasons for intensive research carried out all over the world. One of the main issues regarding studies on GaN-based devices is the resistance and technology of ohmic contacts to n-type GaN, particularly in the structure of HEMT transistors. In contact fabrication methods numerous material and technological difficulties are present such as insufficient conductivity and quality of GaN layers doped with silicon (Si) as well as complicated and limited technology requiring high temperatures.

The aim of the project is to investigate the mechanism of doping GaN thin films with oxygen and the analysis of the mechanism of ohmic contact formation to n-GaN with highly doped n^{++}-GaN:O subcontact layer. The conception of investigations is based on the fact that oxygen is a donor impurity in undoped GaN thin films with high solubility and low activation energy, that may allow to obtain high carrier concentration. Oxygen has not been investigated as intentional donor dopant in GaN. Theoretical predictions do not indicate the deterioration of the GaN films for high oxygen concentrations, as in case of films doped with Si. Oxygen has not been studied as an intentional donor dopant in this semiconductor, which means the possibility to create an alternative to the commonly used Si. The highly conductive subcontact layer may allow to achieve low contact resistance without additional heat treatment. The idea of the project also applies to the use of magnetron sputtering as a simple and scalable method of producing electronic materials and structures enabling the deposition at low temperatures.

Structural, electrical, transport, optical properties and chemical composition of GaN and GaN:O films as well as electrical parameters of ohmic contacts will be comprehensively characterized. Finally, the influence of ohmic contacts as source and drain ohmic contacts in HEMT transistor on the electrical characteristics of the device will be analyzed. The measurable effect of the project will be the development of competitive technology of ohmic contacts to n-GaN with highly doped n^{++}-GaN:O subcontact layer as source and drain ohmic contacts to AlGaN/GaN HEMT transistors by means of magnetron sputtering. Obtained results will expand the current state of knowledge in the field of nitride semiconductors and may be the basis for further research on semiconductor materials and devices.